DU PONT TRADEMARK CROLYN * MAGNETIC TAPE

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INTRODUCTION

Du Pont research in inorganic chemistry and magnetism has produced a chromium dioxide of high purity, for the first time. This accomplishment makes possible new standards of performance for precision magnetic tape. CROLYN* magnetic tape utilizes Du Pont's proprietary chromium dioxide, incorporated in specially formulated binders, coated on MYLAR* polyester film.

Chromium dioxide (CrO_2) was first discovered in the course of hydrothermal synthesis studies above the critical temperature of water. Under the synthesis conditions — above 373°C and 3000 atmospheres of oxygen—chromium dioxide was formed from chromium trioxide. Chromium dioxide is the only known ferromagnetic oxide.

Chromium dioxide has a higher magnetic moment per unit of volume than gamma iron oxide typically used in conventional magnetic tape. This characteristic of chromium dioxide leads to many practical advantages in the various industries which rely on magnetic tape for information recording. In general these advantages derive from (a) higher signal output at the same degree of resolution and (b) better resolution at a given level of signal output.

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PROPERTIES OF CHROMIUM DIOXIDE

Chromium dioxide is a black, semi-conducting compound with a density of 4.9 grams per cubic centimeter. It is synthesized in the form of acicular, single domain particles which can be varied in length from 4 to 400 microinches with a normal aspect ratio of ten to one. Coercivity can be varied from 25 to over 700 oersteds. The particles have the rutile crystal structure and exhibit both shape and magnetocrystalline anisotropy.

The saturation flux density (B_s) for chromium dioxide is 6100 gauss and the Curie Point is 126°C.

Figure 1—This electron photomicrograph of chromium dioxide crystals, at 50,000 X magnification, illustrates the uniform, needle-like particles which permit better orientation.

TYPICAL PROPERTIES OF CROLYN* MAGNETIC TAPES

CROLYN magnetic tapes are well suited to the precision needs of video, instrumentation, and computer recording. Performance characteristics of CROLYN magnetic tape in each application are given in succeeding pages of this book. In general, CROLYN magnetic tapes selected for development have coercivities of 360 to 450 oersteds, with residual flux densities up to 1600 gauss. The excellent dispersibility of chromium dioxide and the narrow range of particle size lead to tapes with optimum smoothness and an orientation (B_r/B_s) of 0.90. Additional benefits include low noise and low print through. Coating thicknesses of present CROLYN magnetic tapes range from 80 to 250 microinches with residual flux ($\phi_r/½''$) of 0.40 to 1.25 maxwells.

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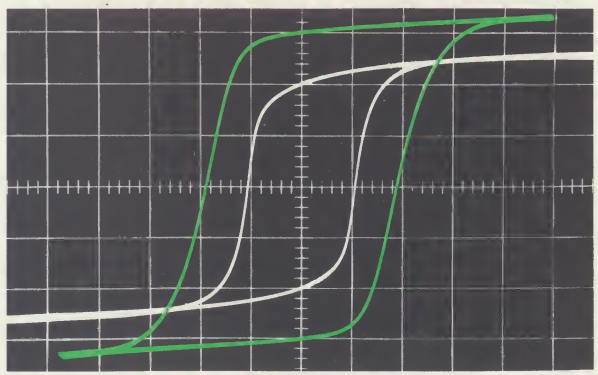

Figure 2—Typical hysteresis loops comparing CROLYN magnetic tape (shown in green) with high quality iron oxide tape.

VIDEO TAPE RECORDING

In video tape recording, picture quality is dependent upon the frequency response of both equipment and tape to produce the fine picture detail. Contrast is dependent on high signal-to-noise ratio (S/N ratio). S/N ratios of CROLYN* magnetic tape and iron oxide tape are compared in Figure 3. The increased S/N ratio can be used to advantage in recording narrower tracks or to reduce the head-to-tape speeds. The improved S/N ratio of CROLYN magnetic tape also represents an important benefit in magnetic tape duplication where losses of 3 db or more per generation are unavoidable.

In the demonstration pictured at right, the relative head-to-tape speed, on a commercially available helical scan video tape recorder, was reduced to half the designed speed. The picture from iron oxide tape (Figure 4) exhibits signal degradation which is particularly acute in the highlight regions. In this FM system, these regions are represented on the magnetic tape by the shortest recorded wave lengths and highlight dropouts result from inadequate high frequency response. Poor S/N ratio causes excessive picture "snow," which is evident. CROLYN magnetic tape (Figure 5) exhibits a high quality recorded image.

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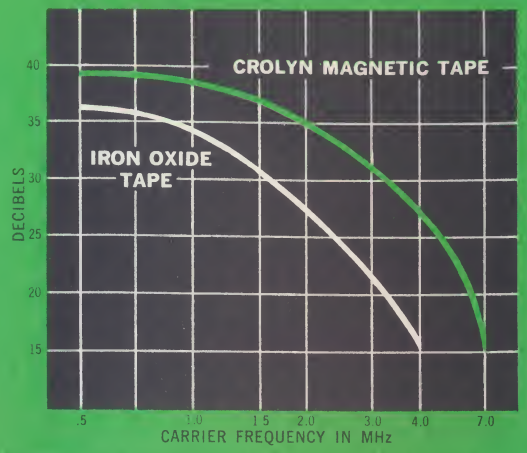

Figure 3—Signal to noise ratio-helical scan video recorder at 430 ips head-to-tape speed.

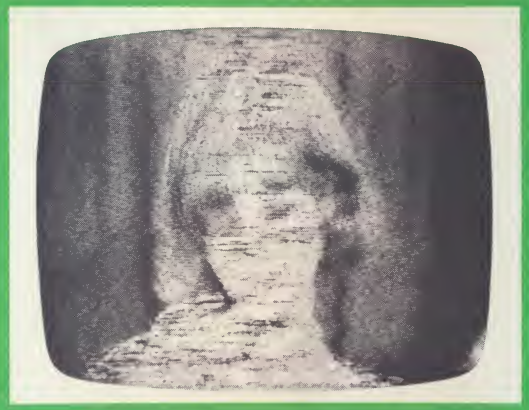

Figure 4—Iron oxide tape, played through a video recorder modified to operate at half the design head-to-tape speed.

Figure 5—CROLYN magnetic tape played through the same modified recorder.

INSTRUMENTATION RECORDING

In tests on a variety of wideband instrumentation recorders CROLYN* magnetic tape typically shows S/N ratios 3 to 8 db greater than high-quality iron oxide wideband instrumentation tape. The performance advantage seen for CROLYN magnetic tape derives from the higher magnetic moment, better linearity, and higher coercivity of chromium dioxide. At the shortest recorded wavelengths—60 microinches on 2 MHz recorders—the superiority of CROLYN is most pronounced. The performance advantage of CROLYN tapes over high-quality iron oxide tapes appears to widen at still shorter recorded wavelengths based on results from experimental and laboratory recording equipment.

The practical benefits which can be expected from the use of CROLYN magnetic tape in instrumentation recording are:

- Increased S/N ratios
- Slower speed operation without loss of signal quality; for longer recording time and greater information storage
- Greater band width at conventional recording speeds

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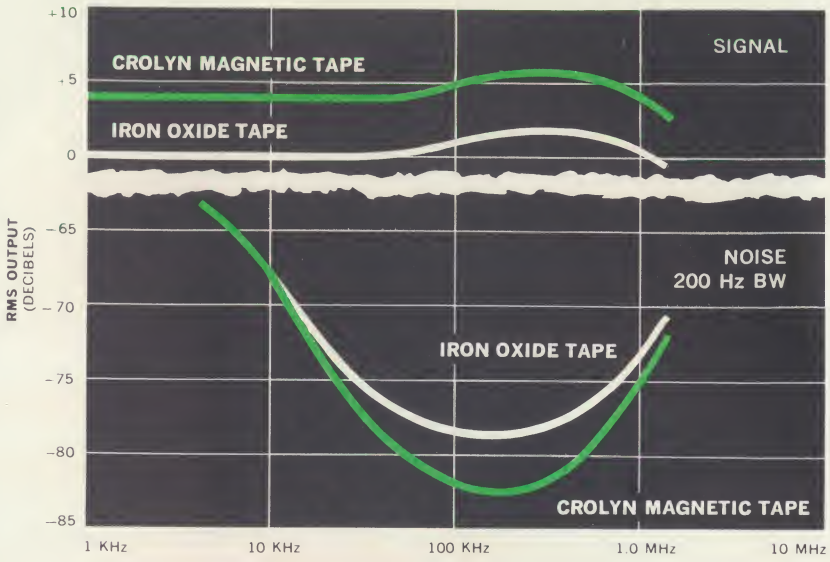
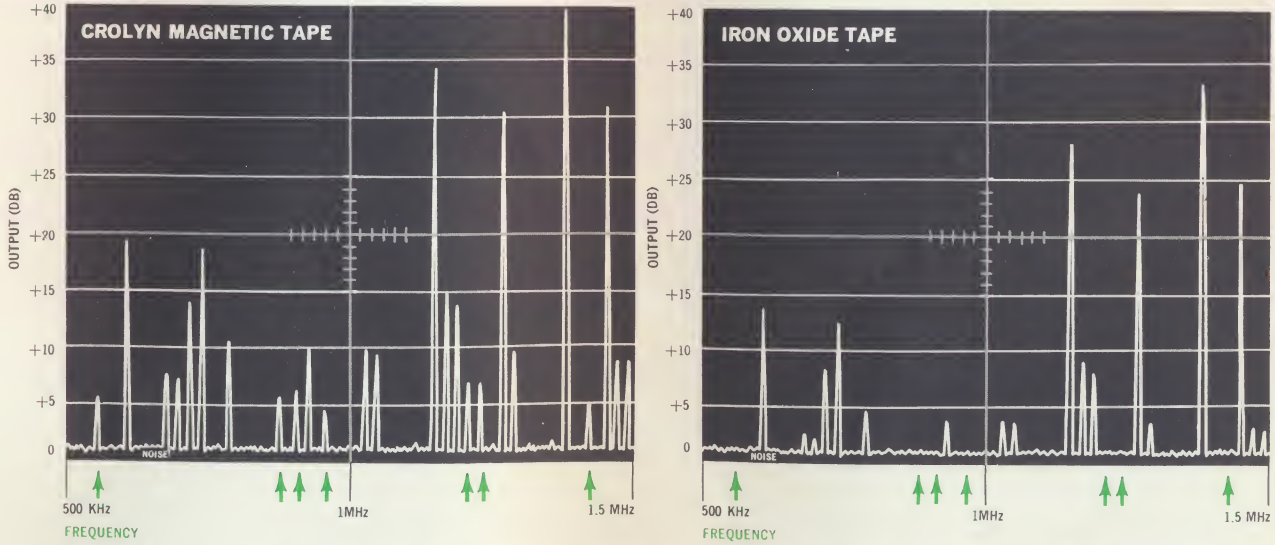
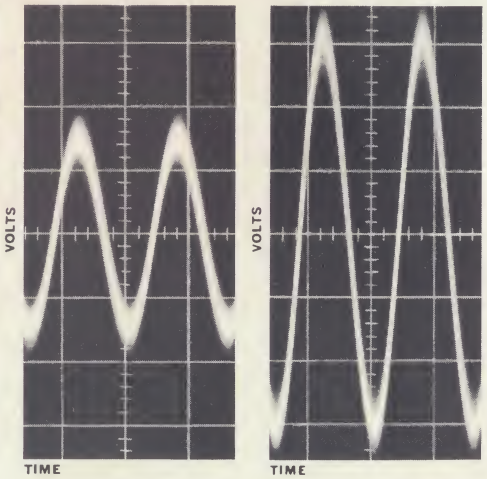


Figure 6—Higher signal and lower noise are characteristic of CROLYN* magnetic tape performance over the full frequency range of a commercial 1.5 MHz recorder at 120 ips, 1% third harmonic distortion.



Figures 7 & 8—Predetection recording of the AM broadcast band (540-1600 KHz). Iron oxide tape fails to capture as much of the signal as CROLYN magnetic tape. Green arrows indicate stations distinguishable on CROLYN but not on iron oxide tape.



Figures 9 & 10—Comparison of outputs on a wideband recorder from high quality iron oxide instrumentation tape (left) and CROLYN magnetic tape. Signal-200 KHz, recorded at 15 ips.

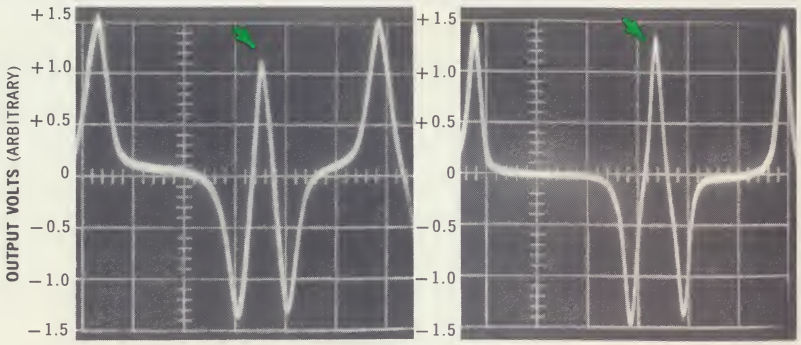


Figure 11—Iron oxide tape at 800 bpi

Figure 12–CROLYN* magnetic tape at 800 bpi

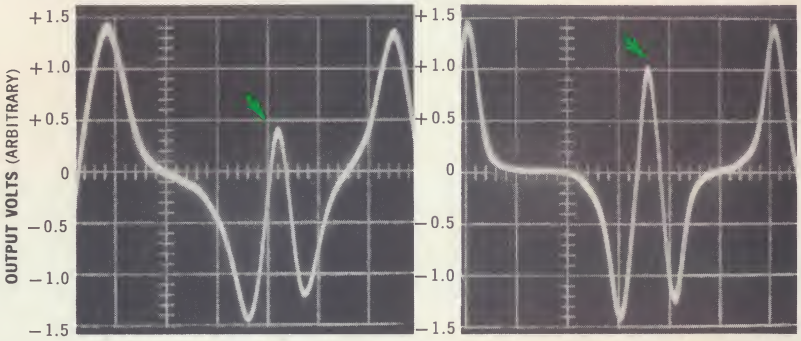


Figure 13—Iron oxide tape at 1600 bpi

Figure 14–CROLYN magnetic tape at 1600 bpi

COMPUTER TAPE RECORDING

The superior magnetic characteristics of chromium dioxide allow CROLYN* magnetic tape with half the coating thickness of current commercial computer tapes to provide the same peak-to-peak signal amplitude when recorded on conventional computer transports. Such a compatible CROLYN magnetic tape exhibits less pulse crowding and less peak shift even at the currently used information packing densities of 800 bits per inch NRZI. In Figures 11 and 12 the resolution capability of CROLYN magnetic tape and a high quality iron oxide computer tape are compared using the isolated "3 ones" pattern at 800 bpi as a test. With the greater resolution capability of CROLYN magnetic tape, it has been demonstrated to be technically feasible to extend the tape packing density beyond 800 bits per inch on existing transports. Figures 13, 14 and 15 show how information integrity is maintained at 1600 bits per inch NRZI on CROLYN magnetic tape, compared with a high-quality iron oxide computer tape.

CROLYN magnetic tape also offers substantial performance advantages over commercial iron oxide computer tapes in high density digital recording systems employing phase encoding. In Figure 16 the same CROLYN magnetic tape that provides compatible output in 200/556/800 bit per inch NRZI systems is compared with iron oxide tapes at packing densities of 200-8000 flux changes per inch.

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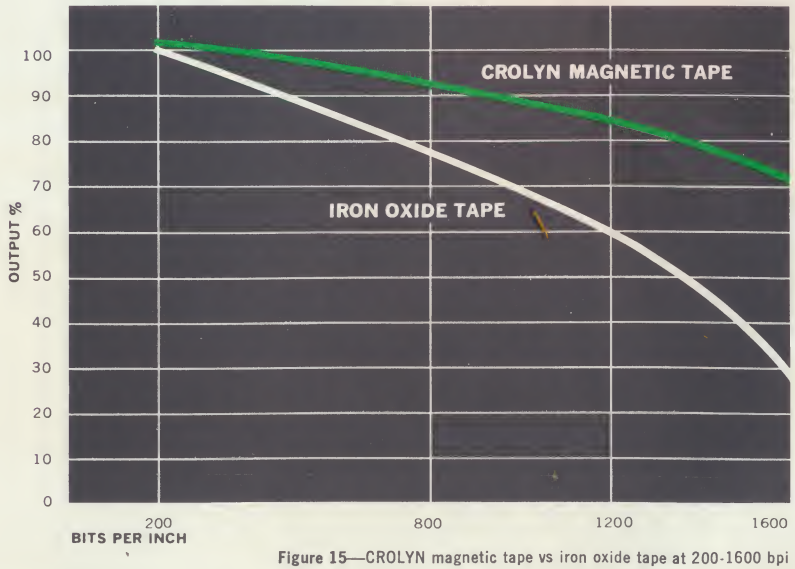

Figure 15—CROLYN magnetic tape vs iron oxide tape at 200-1600 bpi

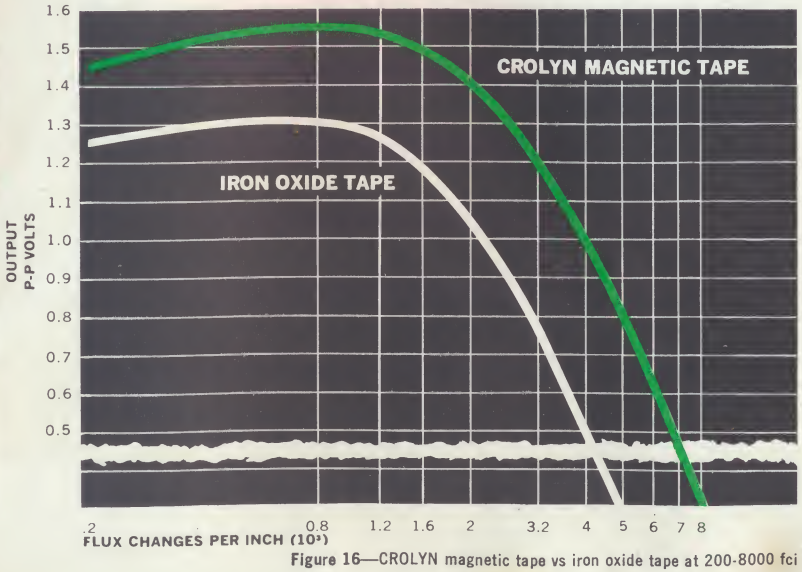

Figure 16—CROLYN magnetic tape vs iron oxide tape at 200-8000 fci

FURTHER INFORMATION

Performance advantages are also seen for CROLYN* magnetic tape in audio recording applications; however, the tape is not designed for conventional audio recording equipment.

In many cases, CROLYN magnetic tapes can be used interchangeably with conventional iron oxide tapes. CROLYN characteristics described were obtained from commercial recording equipment. In some cases equipment modifications were made to demonstrate the superior tape performance characteristics that are achievable. It is fully expected that the potential advantages of CROLYN magnetic tape will lead to future equipment design changes that will improve levels of recording precision, performance, and efficiency.

Interest in the development of extended performance systems utilizing CROLYN magnetic tape is welcomed. Inquiries should be directed to E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, CROLYN Magnetic Tape, Centre Road Bldg., Wilmington, Delaware 19898

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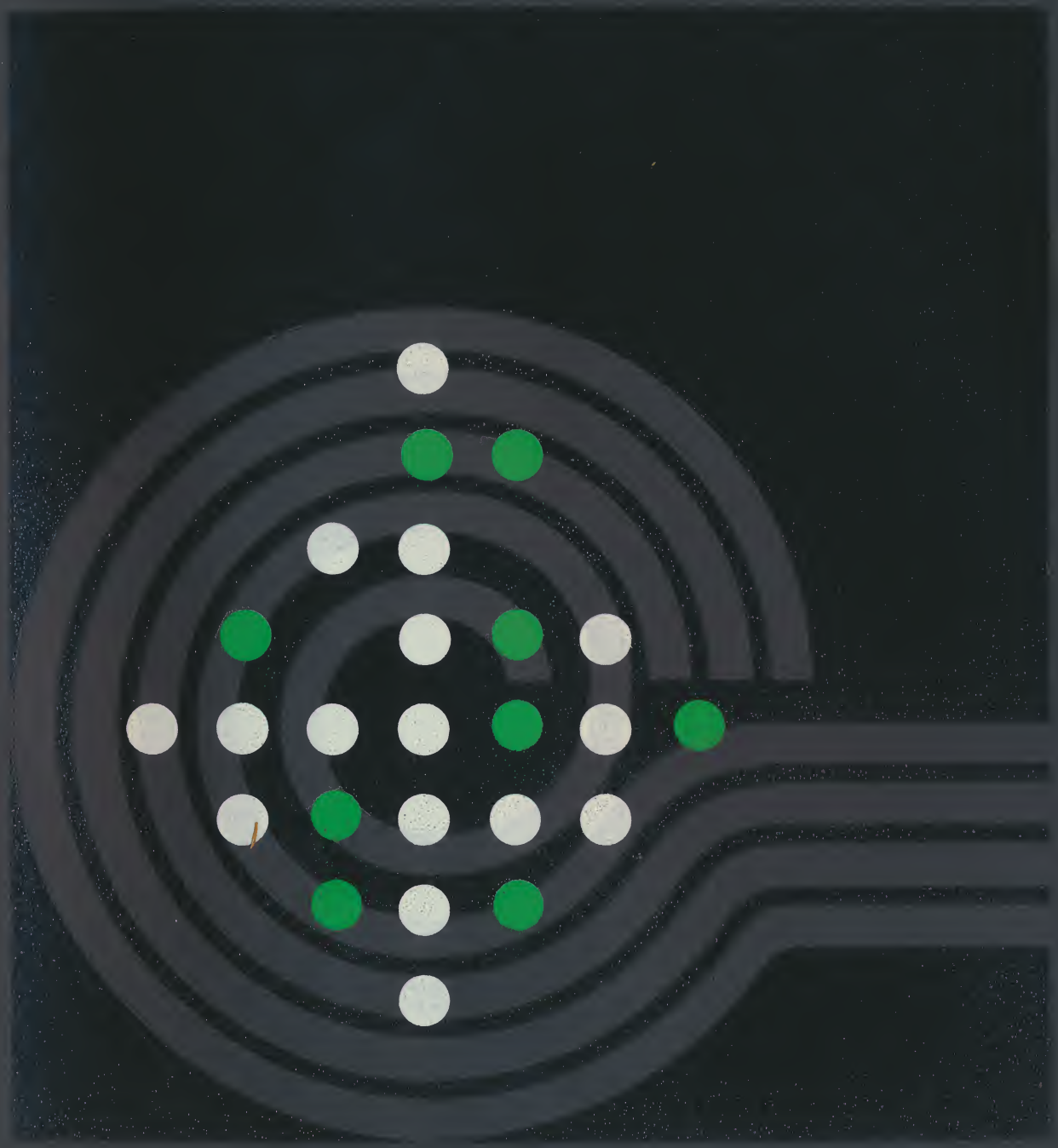

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